$$R_N(n) = \begin{cases} 1 & 1 \le n \le N-1 \\ 0 & \text{other} \end{cases};$$

[0021] 4) multiply $x((n-iM))_{p,N}R_N(n)$

$$\eta(n, i) = e^{j\frac{1}{2}\cot\alpha\square[-2\square iM\square n+(iM)^2]\Delta t^2}$$

by point-by-point to obtain $\phi(n,i)$ as the following:

$$\phi(n,i)=x((n-iM))_{P,N}R_N(n)\square\eta(n,i)\ i=0,1\ldots L-1\ n=0,1,\ldots,N-1 \tag{10}$$

[0022] 5) multiply $\phi(n,i)$ by weighting factors, $r^{(l)}(i)$, and use a combiner to obtain candidate signals $\tilde{x}^{(l)}(n)$ of FRFT-OFDM in the time domain as the following:

$$\tilde{x}^{(l)}(n) = \sum_{i=0}^{L-1} r^{(l)}(i)\square\varphi(n, i),\ n = 0, 1 \ldots N-1,\ l = 1, 2, \ldots S \tag{11}$$

wherein $r^{(l)}(i)$ is the weighting factor with L-length, and S is the number of alternative Fractional random phase sequence;

[0023] 6) transmit the weighting factor $r(i)_{opt}$ that makes PAPR of candidate signals minimum as the sideband information of FRFT-OFDM signals, wherein

$$r(i)_{opt} = \underset{\{r^{(1)}(i),\ldots,r^{(S)}\}}{\operatorname{argmin}} PARP\{\tilde{x}^{(l)}(n)\} \tag{12}$$

[0024] 8) use a Digital-to-Analog Converter (DAC) to convert the transmitting FRFT-OFDM signals with minimum PAPR to analog signals which are further amplified by a High-Power Amplifier (HPA) after modulated by carrier; and

[0025] 9) submit the amplified analog signals to a transmitting antenna.

[0026] The present method can effectively reduce the PAPR of the FRFR-OFDM system while maintaining the system's BER performance. When the number of candidate signals is the same, the PAPR performance of the present method was found to be almost the same as that of SLM method and better than that of PTS method. The method of the invention has lower computational complexity compared to SLM and PTS. Because the present method uses fast discrete fractional Fourier Transform, the computational complexity of the present method is equivalent to that of FFT and it is easy to implement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** shows a block diagram of the FRFT-OFDM system.

[0028] FIG. **2** shows a block diagram of the SLM method for PAPR reduction.

[0029] FIG. **3** shows a block diagram of the PTS method for PAPR reduction.

[0030] FIG. **4** shows a block diagram of the CSPS method for PAPR reduction.

[0031] FIG. **5**. shows a block diagram of a PAPR reduction method of the present invention.

[0032] FIG. **6**. Comparison of the BER peerformance with or without the PAPR reduction method of the present invention.

[0033] FIG. **7**. Comparison of the PAPR reduction with the method of the present invention when L=2, 4.

[0034] FIG. **8**. Comparision of the PAPR reducation by the SLM method, the PTS method, and the method of the present invention when the number of candidate signals is 32 and the sampling factor J=1.

[0035] FIG. **9**. Comprison of the PAPR reduction by the SLM method, the PTS method, and the method of the present invention when the number of candidate signals is 32 and the sampling factor J=4.

DETAILED DESCRIPTION

[0036] More details of the method for reducing PAPR in FRFT-OFDM systems are described below.

[0037] A. Design of Fractional Order Random Phase Sequence

[0038] R is a random phase sequence with a length L, wherein R=[R(0), R(1), . . . , R(L−1)] (which $R(i)=e^{j\theta_k}$, i=0,1, . . . L−1, θ_k evenly distributed in the [0,2,π]). N is an integer multiple of L, that is N/L=M. The sequence R is periodicity extended into the random phase sequence with a length N, Q (Q=[Q(0), Q(1), . . . , Q(N−1)]), that is:

$$Q(m)=R((m))_L,\ m=0,1\ldots N-1 \tag{13}$$

[0039] Use phase factor

$$e^{j\frac{1}{2}\cot\alpha\square m^2\Delta\mu^2}$$

as weighting factors for each element in the Q sequence to obtain B=[B(0), B(1), . . . , B(N−1)], which is the fractional random phase sequence to be used.

$$B(m) = Q(m)\square e^{j\frac{1}{2}\cot\alpha\square m^2\Delta\mu^2},\ m = 0, 1 \ldots, N-1 \tag{14}$$

wherein $\alpha=p\pi/2$,

$$\Delta\mu = \frac{2\pi\square|\sin\alpha|}{N\square\Delta t}$$

is sampling interval of p-Order fractional Fourier domain sampling interval; and dt is sampling interval of the continuous signal.

[0040] It can be seen from formula (11) and formula (12) that the fractional order random phase sequence is obtained by periodically extending a short random phase sequence to the same length as FRFT-OFDM signals and then using elements of the extended random phase sequence as the weighting factors for the FRFT-OFDM signals.